Keep America Connected!

National Campaign for Affordable Telecommunications

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

April 13, 1998

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
Room 222, 1919 M Street, N.W.
Washington, D.C. 20554

In the Matter of: RM – ~~9844~~ 9244 Petition of the Allliance for Public Technology Requesting Issuance of Notice of Inquiry and Notice of Proposed Rulemaking to Implement Section 706 of the 1996 Telecommunications Act

Dear Ms. Roman Salas,

Enclosed please find one original and nine copies of Keep America Connected's Comments in the NOI/NPRM to implement Section 706 of the 1996 Telecommunications Act.

Sincerely,

Angela Ledford
Executive Director

No. of Copies rec'd 0+9
List ABCDE

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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APR 13 1998

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Petition of the Alliance for Public Technology	)	
Requesting Issuance of Notice of Inquiry and	)	RM-9~~8~~244
Notice of Proposed Rulemaking to Implement	)	
Section 706 of the 1996 Telecommunications Act	)	

Comments of

KEEP AMERICA CONNECTED

April 13, 1998

Keep America Connected[1] submits the following Comments in the above referenced proceeding.

Keep America Connected endorses the Alliance for Public Technology's (APT) request that the Commission initiate a proceeding to implement fully Section 706 of the Telecommunications Act of 1996 (the Act). Section 706 directs the Commission and state regulators to encourage the deployment to all Americans of advanced telecommunications capabilities through regulatory initiatives such as price caps, regulatory forbearance, and other action that would remove barriers to investment.

Such capabilities can expand life-long learning opportunities, increase job training and placement resources, enhance the quality of health care, promote independent living and economic opportunities for people with disabilities, build entrepreneurial skills and opportunities for small businesses, and reduce isolation for seniors and remote populations.[2]

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[1] Keep America Connected is a coalition of organizations representing older Americans, people with disabilities, rural and inner city residents, people of color, lower income citizens, labor and local phone companies. The campaign's agenda is to ensure accessible telecommunications for daily life and to enact policies that leads to a modern information infrastructure available to all people.

[2] These goals are shared by the members of Keep America Connected including, African Methodist Episcopal Church, Al Chem, Alliance for Public Technology, Alpha Kappa Alpha, Alpha One, American Agri-Women, American Association for Adult and Continuing Education, American Beekeeping Federation, American Coalition for Ethanol, Association for Gerontology and Human Development at Historically Black Colleges and Universities, Campaign for Telecommunications Access, Central Alabama Health Alliance, Inc., Communications Workers of America, ConnectMissouri, Delta Waterfowl Foundation, Inc., Federation of Southern Cooperatives Land Assistance Fund, Florida Association for the Deaf, Green County Democrat, Henry A. Wallace Institute for Alternative Agriculture, MCIL Resources for Independent Living, Mid-America International Agri-Trade Council, Missouri Center on Minority Health and Aging, National Agricultural Aviation Association, National Association of Commissions for Women, National Association of Development Organizations, National Black Caucus of State Legislators, National Council of Senior Citizens, National Hispanic Council on Aging, National Hispanic Law Enforcement Association, The National Trust, National Latino Telecommunications Task Force, Northern Virginia Resource Center for Deaf and Hard of Hearing Persons, Palm Beach County Association of the Deaf, Inc., Personal Family Service Corporation, Presidents Club for Telecommunications Justice, Southern United States Trade Association, United Homeowners Association, United Seniors Health Cooperative, United States Durum Growers Association, United States Telephone Association, Universal Service Alliance, Virginia Public

Keep America Connected believes that the key to achieving these goals is removing barriers to investment in the local network. To this end, Keep America Connected notes that Bell Atlantic, US WEST and Ameritech have submitted petitions for regulatory relief under Section 706. These petitions seek regulatory relief associated with the deployment of digital subscriber line (xDSL) services. xDSL services are one of many new technologies that can help to meet the goals of Section 706 by providing small business and residential users with access to the Internet that is comparable in speed to that enjoyed today by larger organizations. Keep America Connected notes that xDSL service has recognized constraints associated with the distance of a customer from a central office and conditions of the line serving that customer. In addition, xDSL may not be competitive in all markets with other high-speed, high-capacity services. xDSL alone will not achieve fully the goals of Section 706. But xDSL service is part of the solution; a part that can be available to customers today if the Commission acts under the authority granted by Section 706.

Attached hereto as Appendix 1 is a report prepared by Robert A. Crandall and Charles L. Jackson titled "Initial Report on Regulation of LEC ADSL Services." The Crandall-Jackson report examines the growing demand for high-speed, high capacity service, the potential benefits of ADSL services for residential and small business customers, and the barriers to the widespread deployment of ADSL services.

The study concludes that the Commission can encourage deployment of ADSL services by local telephone companies by implementing rules that "reflect the competitive nature of DSL offerings and create the proper long-run incentives for DSL

Interest Coalition, Wheat Quality Council, Women Involved in Farm Economics, Women of Distinction, World Institute on Disability, and Youth Entrepreneurial Leadership Institute.

rollout by the LECs." (at i). ADSL service can be competitive with other new services, including cable modems and wireless services, if the Commission adopts appropriate regulatory incentives. More specifically, the Crandall-Jackson study concludes that in the areas of price regulation, unbundling requirements, and universal service requirements the Commission can act to remove barriers to infrastructure investment for ADSL service.

Conversely, if the Commission fails to act or acts to impose regulatory requirements associated with plain old telephone service (POTS) on ADSL, consumers are likely to have fewer competitive choices and the goals of Section 706 will be subverted.

Clearly, the Crandall-Jackson report suggests that to fulfill its obligations under Section 706, the Commission needs to not only grant the relief sought by Bell Atlantic, US WEST, and Ameritech in their petitions but to also take a broader view of the regulatory landscape as requested by the APT. APT's petition for rulemaking offers the Commission an opportunity to create the appropriate incentives for deployment of competitive high-speed, high-capacity services (including but not limited to ADSL services) for all Americans not only by local telephone companies but also by all telecommunications services providers.

The APT petition compliments and builds upon the petitions submitted by the incumbent local exchange carriers. Keep America Connected urges the Commission to give these proceedings the highest priority, grant the relief requested for deployment of ADSL services, and take other appropriate action to remove further the barriers to infrastructure investment as provided in Section 706.

Respectfully submitted,

Angela Ledford
Executive Director

April 13, 1998

Initial Report on Regulation of LEC ADSL Services

by

Robert W. Crandall
and
Charles L. Jackson

Prepared for
Keep America Connected!

April 13, 1998

Executive Summary

New high-speed digital subscriber line (DSL) services, offered by local telephone companies, will provide small businesses and residential users with access to the Internet that is comparable in speed to that enjoyed today by larger organizations. We have been asked to analyze the economic viability of these services and potential impacts of regulation on the incentives of local exchange carriers (LECs) to invest in and deploy technologies associated with DSL. In this paper, we describe some preliminary results derived from our models of the demand and cost of digital subscriber line services.

It is clear to us that these new DSL services will have to compete with other comparable services, including cable modems, wireless services, and services provided by competitive carriers and Internet service providers (ISPs) who use unbundled loops obtained from the LEC itself. This competition will limit regulators' abilities to require LEC provision of DSL service in some markets at rates that are significantly above cost in order to cross-subsidize service in other areas. For example, the price of DSL service in urban areas cannot be raised to generate significant cross-subsidies to support DSL service in less dense neighborhoods. If regulators attempted to do so, the LEC would lose its urban subscribers to others.

Our preliminary analysis also indicates that the threat of binding price regulation several years into the future is sufficient to change the net present value to a LEC of offering DSL service from positive to negative. Moreover, if regulators require geographic ubiquity of DSL service, the profitability of DSL service plummets.

Our conclusion is clear. The FCC should, whenever possible, implement rules that reflect the competitive nature of DSL offerings and create the proper long-run incentives for DSL rollout by the LECs.

The table below outlines the impacts we have identified.

Effects of Regulation on DSL Service		
Regulatory Scenario	**Effect on LEC Incentives**	**Effect on Market**
Price Regulation		
Strict rate-of-return	Incentives to invest would be greatly weakened.	Slower development of service, less competition, higher prices.
Price caps set in 2003 on forward-looking costs at that time	Incentives to invest would be significantly weakened.	Slower development of service, less competition, higher prices.
Regulatory depreciation	Rapid technological change and the assurance of competition would increase the risks of using regulatory depreciation. In addition, regulating depreciation would require regulation of prices generally. Again, incentives to invest would be significantly weakened.	Weakens LEC incentives to invest. May also deter competitors from investing in early years.
Universal service requirements		
Requirement to provide DSL service to all households served by a DSL-capable central office.	Such regulation would give the LECs the incentive to deploy DSL technologies only in central offices where the vast majority of loops could support DSL service.	Restriction of LEC supply of DSL services to urban areas and to slow-growth areas.
Requirement to provide DSL service at all central offices.	Some smaller central offices, especially those with few loops capable of supporting DSL service, would be uneconomic. Consequently, the LEC's incentives to invest would be reduced.	May deter some LECs from initiating DSL service.
Requirement to provide DSL service to all LEC subscribers, if requested.	Cost of providing DSL service is significantly increased. Under all reasonable scenarios, the LEC would lose money from entering business.	Less competition, slower service rollout.

Unbundling requirements Loop unbundling	Two quite different impacts: 1. The ability of others to provide DSL over LEC facilities would create difficult problems in managing interference in the outside plant. 2. The ability of others to provide DSL over LEC loops would ensure competition.	Managing interference would create some difficult, but not unsolvable, regulatory problems. Would weaken or remove the argument that DSL will not be a competitive service. Would ensure that LECs face DSL competitors with deaveraged costs.
Unbundling applied to DSL facilities	Would raises costs for LEC network.	Would raise costs to consumers.
Assurances that DSL costs and revenues will be treated below the line by regulators	LEC would have to consider the DSL market as would other businesses. LEC's incentive to pursue market quickly to gain partial first-mover advantage would be increased.	Would speed availability of DSL service.

About the authors

Dr. Robert W. Crandall is a senior fellow in the Economics Studies program at the Brookings Institution. He has written several books on telecommunications economics and policy.

Dr. Charles L. Jackson is an engineer who writes extensively on telecommunications policy issues.

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1. Introduction

The rapid growth of the Internet has created new demands for communications capabilities. Many large organizations have high-speed access to the Internet using T1 lines connected to their organization's local area networks. Small businesses and residential users lack comparable access to the Internet.

In our study, we consider three aspects of a new digital subscriber line (DSL) service that local telephone companies are now preparing to offer to small businesses and residences::

- the value of this service to residential and small business consumers,
- the likely competitive environment, and
- possible regulation of LEC provision of DSL service and its impacts.

This report summarizes our work and presents our preliminary results.

2. Growth of the Internet and Need for High-Speed Access

Given the relatively recent development of the Internet and the even more recent development of widespread use of the Internet by households, there is only limited information on residential Internet demand use and even less information on the demand for high-speed digital services. Much of the information on Internet use comes from surveys in which respondents are self-selected, thereby imparting a substantial upward bias to the estimates.

a. Growth of the Internet

There are very good data on the growth of Internet hosts. Examination of the data shows that the growth has not been diminishing; it continues to grow at an annual rate of about 60% per year.

The growth of Internet hosts or domains clearly reflects growth in the potential usefulness or attractiveness of the Internet to businesses and consumers alike, but it does not provide a measure of the extent or intensity of consumer interest in the Internet. Nor does it have implications for the value of greater speed in accessing the Internet.

A review of several studies of residential computer use indicates that computer use has been growing most rapidly in homes. Between 1984 and 1993, the number of persons age 18 or over with access to a computer grew by 220%, but the number using a computer *at home* grew even more rapidly, by 289%. Still, even in 1993, only 26% had access to a computer and only 16% actually used a home computer. As we have seen, home computer penetration has now risen to more than 40% of U.S. households, suggesting a continuing growth of home-computer penetration of nearly 15% per year. Obviously, computer penetration cannot continue to grow at this rate for very long because complete saturation would be reached in less than six years at this growth rate.

By 1996, home Internet subscriptions had grown substantially from only two years before. According to PNR's ReQuest III survey of 31,000 households, 14.8% of homes subscribed to an Internet service in 1996.[1] Among 8,857 telephone- subscribing households surveyed by PNR in 1996 in their annual Bill Harvesting survey, 17.7% indicated that they used the Internet.[2] A January 1997 survey of 48,000 households by PNR and Market Facts, Inc. found that 16% of households were Internet subscribers.[3] Of those households surveyed by the Nielsen March 1997 Home Technology Survey 14.9% reported that they subscribed to a commercial on-line service.[4]

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1 Paul N. Rappoport, Lester D. Taylor, Donald J. Kridel, and William Serad, "The Demand for Internet and On-Line Access," unpublished ms, 1997.

2 PNR, Bill Harvesting III, 1996.

3 Rappoport, *et.al.*

4 Nielsen Media Research, *Home Technology Report*, March 1997.

Commercial estimates of adult Internet access generally conform to the above survey data. *Business Week* estimated that 40 million people were Internet users.[5] An April 1997 survey by FIND/SVP estimated that there were 40-45 million Internet users.[6] In November 1996, Louis Harris estimated that there were 35 million adult Internet users, and in October 1996, IDC Research estimated that there were 31.4 million adult users.[7]

Thus, current evidence suggests that about one-sixth of Americans use the Internet. These data are largely confirmed by recent data on the number of subscribers for the leading Internet service providers.

The figures offered above on home computers and Internet use are not static. Rather, they are snapshots of a rapidly changing phenomenon. Clearly, the Internet is delivering enormous value to parts of the American economy. The natural question arises "What actions will increase the value delivered by computers and the Internet?"

b. Need for High-Speed Access

A variety of sources indicate that high-speed access will improve consumers' satisfaction with Internet services. The widespread complaint that WWW means worldwide wait instead of worldwide web illustrates consumer discontent with current Internet service levels. Trials with DSL services and cable modems show that consumers strongly value higher speed access and are willing to pay extra for such speed. Survey data also suggest that a substantial share of home-computer users would pay for higher-speed connections and that this demand is reasonably price sensitive.

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5 http://www.cyberatlas.com/demographics.html.

6 http://etrg.findsvg.com/internet/interest.html.

7 http//:www.idcresearch.com.

3. DSL Services and the Likely Competitive Environment

Three technological foundations – telephone lines, cable television, and wireless – offer alternatives for improved consumer access to network services.

a. Telephone Lines

Copper telephone lines can carry far more data per second than is normally transmitted by the modems in home computers. The shortcomings of computer modems derive from the fact that they are designed to work on both local and long-distance connections. But most local switches and all long-distance connections transmit signals in only a narrow band of frequencies. A modem connected to the copper telephone wire at the home can communicate with a modem at the telephone office (with the signal being separated from the telephone line before the connection through the voice switch) at speeds far higher than are possible on dial-up connections. The technologies for such high-speed local communications over telephone lines are known as digital subscriber line, or DSL, systems.

Unfortunately, several constraints limit the performance of these connections. The limitations can be so severe that service delivery becomes impossible. One limitation is distance. The longer the copper wire from the telephone company to the consumer, the harder it is to transmit digital information over that wire. Thus, when the range is a few hundred yards, data rates in the tens of millions of bits per second can be achieved. As range increases, practical data rates fall. Some DSL products have a maximum range beyond which they do not work at all – typically two or three miles for a DSL system capable of six million bits per second. A second limitation arises from the condition of the copper wire. Wire with extra connections, called bridge taps, works fine for ordinary voice telephone service, but it works poorly for DSL services. Other uses of the wires in a cable create a third class of problems: energy can leak from one pair of wires in the cable to others – a property called *crosstalk.* Crosstalk between DSL services using different standards but running in the same cable can seriously damage performance.[8]

b. Cable Modems

The cable industry can also provide the route for high-speed communications to the home. Cable modems are capable of impressive data rates – in the millions to tens of millions of bits per second.[9] Working with manufacturers, the cable industry has defined a standard for cable modems called the Multimedia Cable Network System (MCNS) specification. One example of this technology is the General Instruments (GI) SURFboard cable modem model SB1000, which was recently launched for retail sales.

Cable modems use the cable plant for the high-speed link from the cable system headend to the consumer's home. If the cable system is equipped for two-way operation, the return signal from the consumer can flow over the cable network. Alternatively, if the cable system lacks two-way capabilities, a telephone connection can be used for the return path.

c. Wireless

Wireless (radio) technologies offer the third major technical alternative. Today, there are two wireless technologies that are widely available and that are used for Internet access – cellular digital packet data (CDPD) and Hughes DirecPC. CDPD is a packet data communications technology that uses cellular frequencies and infrastructure. CDPD carries data at only 19.2 thousand bits per second – slightly slower than most dial-up lines and vastly slower than DSL

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[8] Notice that such interference between DSL services in the same cable poses difficult issues when access to loops is unbundled. The technical feasibility of permitting a CLEC to use a specific DSL technology on an unbundled loop depends upon the LEC's current and future plans for the use of DSL technologies (and other similar technologies) on other loops in the same cable. Interference between the technologies depends upon the technology choices made by each firm.

[9] @Home, a cable Internet service provider, claims to offer consumers connections at speeds of 1.5 to 3 million bits per second. See http://www.home.com/home/speed.html.

technologies. CDPD does have the great advantage of mobility. A third alternative, available in a few cities, is Metricom's Ricochet service.

These three wireless alternatives have vastly different characteristics. DirecPC is available everywhere in the forty-eight contiguous states (at least at those locations having a good view south toward the geostationary arc), but DirecPC is not easily portable.[10] CDPD is the slowest of the technologies, but it is portable, supports communications while on the move, and offers coverage in much of the nation. Ricochet is also portable and is somewhat faster than CDPD but is available only in limited areas. Of course, these are all new services. DirecPC was first commercially offered in 1996. CDPD entered the market slightly earlier – 1994. Ricochet had fewer than ten thousand subscribers at year-end 1996. It is far too early to discern the ultimate competitiveness of these offerings.

Although these three services are the primary wireless alternatives for Internet access today, we expect the range of wireless alternatives to increase. Metricom has announced new technology that will increase the data rate on their system to 85 Kbps. In the FCC's WCS auction, Metricom purchased licences covering most of the western half of the forty eight contiguous states and much of the northeast. The next generation of geostationary satellites, due to be operational in two to three years, will support high-speed two-way communications to terminals similar to those used for the DirecPC service today. Several firms are developing low-earth-orbit satellite systems that will support voice and data communications.

In addition to these visible developments, we believe that there are a variety of substantial development efforts in wireless that are not yet public. The FCC, with its PCS and WCS auctions and its authorization of the unlicenced NII band, has made available sufficient radio spectrum to support a wide variety of terrestrial radio systems. Manufacturers and service providers are

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[10] DirecPC is portable in the sense that the equipment can be mounted on a trailer or van and the vehicle moved from place to place. The user must then manually repoint the antenna toward the serving satellite.

working to develop voice and data services that will allow them to compete with existing wireless providers or to meet currently unmet consumer needs.

d. Summary

Competing technologies are evolving rapidly. We do not yet know how consumers value the mix of portability, speed, and cost. Wireless suppliers are working hard to develop technologies that support effective Internet access. Hughes is selling satellite-delivered Internet service to consumers. Cable companies are rolling out cable modems. Such rapid innovation and turbulent competition promises benefits for consumers but increases the risks for service vendors who must invest significant capital in a specific technology.

4. Impediments to LEC Offerings of DSL Service

We have identified the following factors that we believe will slow the adoption of DSL technology by LECs:

- Standards uncertainty,
- Regulation of DSL retail rates,
- The unbundling requirements imposed on LECs,
- The inability of many consumers' loops to support DSL, and
- The rapid but uncertain evolution of competing technologies.

Let us consider each of these in turn.

a. Standards Uncertainty

There are multiple, competing standards for DSL – offering different levels of performance, ease of installation, and cost. It is unclear which of these standards will prevail in the market.[11] An early investment in a technology that ultimately was not widely adopted in the marketplace would have to be written off much earlier than an investment in a technology that is widely adopted. LECs have an incentive to delay investment until the winning technology is more clearly identified.

b. Regulation of DSL Prices

The specter of price regulation of DSL services is another factor that weakens LEC incentives to move quickly to adopt DSL technologies. LECs run the risk that regulators will limit the upside if DSL is highly successful.

c. Unbundling Requirements Imposed on LECs

Under FCC rules adopted after passage of the 1996 Telecommunications Act, LECs are required to unbundle their networks where technically feasible. This unbundling requirement appears to affect DSL services in three ways. First, LECs are required to permit other local carriers to use their loops – so-called *loop unbundling.* Such loop unbundling means that LECs will face DSL competition, at least in denser areas, from competitors who will use the LEC's own loops to gain access to consumers. Such competition will preclude charging rates that are substantially above cost for DSL service or using urban DSL revenues to cross-subsidize rural DSL services.

Second, if LECs supply DSL services as part of their regulated carrier offerings, then the obligation to unbundle may run to elements of the network supporting the DSL service. Some

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[11] The recent announcement by Microsoft, Intel, and Compaq together with several of the larger LECs of support for a specific version of DSL may have reduced concern about standards uncertainty. However, there still appears to be substantial uncertainty about such standards. See *U S West Scrambles DSL Picture*, Fred Dawson, MultiChannel News, Vol. 19, No. 6, February 9, 1998.

parts of this network may be relatively amenable to unbundling (e.g., a frame-relay cloud used to carry IP packets back from central offices to ISPs), but other parts of this network (e.g., the data bases used to support customer IP numbering) may pose substantial cost and management burdens if an unbundling requirement is applied.

Rolling out a new and relatively poorly understood technology (DSL-to-ISP connectivity) runs the risk of creating features that competitors will ask to have unbundled even though such unbundling is technically infeasible. At best, such requests impose regulatory costs and permit the LEC to be painted as recalcitrant and opposed to unbundling. At worst, the LEC can be assigned an impossible task.

The third unbundling concern associated with DSL service comes from the significant use of subscriber-loop carrier in local telephony. In modern subscriber-loop carrier systems, fiber is run to the neighborhood and the voice signal is transmitted digitally over the fiber. In the neighborhood, the digital signal is converted to an analog speech signal and carried the rest of the way to the subscriber over copper pairs. Some parties have asked LECs to unbundle the their networks at the point of connection between the fiber and copper in digital-loop carrier systems. LECs have strongly resisted such requests.[12] If LECs begin installing DSL capabilities at the interface used for the subscriber-loop carrier, they can anticipate that there will be additional pressures for unbundling at this point.

d. Inability of Many Loops to Support DSL

Although many loops will not support DSL services, the exact fraction of loops that will not support DSL is uncertain and varies with the technology. However, it is clear that longer loops

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[12] LECs observe that the equipment cabinets used for such interconnection are typically sized to support the communications demand in the neighborhood they serve and do not permit the collocation of equipment from other service vendors. LECs also point out issues involving the use of maintenance and testing equipment on such unbundled subloops. Finally, privacy issues appear to be more of a concern in this context than with central office collocation.

(beyond 12,000 to 18,000 feet from the central office) are less capable of supporting DSL services. Similarly, loops served by digital-loop carrier technologies cannot support central-office-based DSL services. Different sources give different estimates of the fraction of loops that will support DSL services. We believe that the fraction of loops supporting DSL service will vary substantially among LECs and central offices. An urban central office with no loop carrier and short loops may be able to support DSL on 80 or 90% of its loops. In contrast, a rural central office with many long loops and significant use of loop carrier may be able to support DSL on only 15 to 20% of its loops.

Such uncertainty poses a marketing and political dilemma for LECs that choose to offer DSL service. An inability to serve many customers translates to a restriction in the use of mass media to promote the service. Running an advertisement that encourages a customer to call the business office – only to have the business office tell the customer, "Sorry, that service is not available to you" not only wastes advertising and administrative costs but diminishes the LEC's brand name. Similarly, for a regulated company to provide a service that it can make available in some neighborhoods but not others invites charges of "redlining" and "cream skimming." One must think practical politics here. What happens if a highly regulated company cannot provide DSL service to the mother of the chairman of the state senate committee on commerce because her home is located six miles from the nearest central office? Is a LEC willing to get into a situation in which it will sell DSL services to some plumbing supply stores but not others?

5. The Crandall-Jackson DSL Model

We developed two models to help predict the effects of regulation on LEC incentives to invest in DSL services. The first model, a demand model, predicts the level of residential subscribership to high-speed access services as a function of the price of such high-speed access services, the price of computers and ISP services, and time.

The second model, a cost and market share model, calculates the net present value to a LEC from entering the DSL business in a region as a function of several variables including the evolution of pricing over time, the presence and strength of competitors, and the pricing of complementary products.

Below, we draw together our demand and cost models to examine the likely profitability of DSL offerings by ILECs. In so doing, we isolate the variables that are critical to prospective profitability and demonstrate the likely effect of alternative regulatory scenarios on the success of DSL offerings.

a. Integration of Demand and Cost Models

We begin by combining the revenue and cost models into a net revenue model for an ILEC with a mixture of wire centers ranging from large centers in heavily urbanized areas to small wire centers in rural locations. The availability of DSL service to households in any of these wire centers depends on the distribution of loop lengths and the condition of those loops.

Our model divides each region into three areas: urban, suburban, and rural. Because loop lengths are shorter in the more concentrated urban areas, we assumed that a new DSL service can reach a maximum of 80% of urban subscribers, 70% of rural subscribers, and 50% of rural subscribers.[13] Moreover, we assumed that DSL is rolled out more slowly in rural and suburban areas than in urban areas. In urban areas, all wire centers are equipped with DSL in the first year, whereas only 10% are so equipped in rural and suburban areas in the first year. We assumed that the share of DSL-equipped wire centers increases linearly up to the tenth year so that 100% of suburban offices and 50% of rural offices are finally equipped with DSL.

The demand for DSL services depends on the real price of the service. We assumed that subscribers are initially required to pay a $200 installation charge that they amortize at $50 per year. Therefore, we added this $50 per year to the annual subscriber charges to estimate demand.

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[13] The model allows the user to vary these assumptions to reflect different telephone-plant configurations.

In addition, the consumer must purchase a modem, the cost of which also affects his or her willingness to purchase DSL service. We assumed that modems cost $400 initially, but their price declines at a rate of 20% per year. This cost is also amortized at 25% per year. Finally, the customer is assumed to have to invest $100 in inside wiring to accommodate the full DSL service. This cost is assumed to decline at a 10% per year rate and is amortized at 25% per year.

We assumed that all ILEC charges decline at a nominal rate of 10% per year, and we assumed a 2.5% inflation rate over the next ten years. We began with the assumption that rates vary directly with costs and therefore that rates are higher in rural areas than in more populous areas. Specifically, we began with the assumption that our hypothetical LEC serving a 5 million subscriber region offers this service at $360 per year in urban areas, $360 in suburban areas, and $480 in rural areas. With the demand model derived in Section 3, above, and an assumed rate of nominal price decline of 10% per year, the number of subscribers at the end of the first and tenth years is shown in **Table 5.1.**

Table 5.1

Subscriber Demand for DSL Service

(Share of Households Offered Service)

Year	Rural (P=$480/yr.)	Suburban (P=$360/yr.)	Urban (P=$360/yr.)
1	2.1%	3.5%	3.5%
10	21.8%	21.8%	21.8%

b. Profitability

To estimate the profitability of a new service whose penetration increases over time and that requires relatively long-lived, sunk investments, we need to calculate the present value of all investment, revenue, and current costs over the economic life of the assets. We assumed that ILECs would view any DSL facilities as relatively risky investments with a useful life of no more than five to seven years. After that time, new technologies, perhaps implemented in different media, would render the original DSL technologies economically obsolete. Indeed, this obsolescence may occur even more rapidly.

We assumed that the real cost of capital for risky DSL investments is approximately 10%. (This corresponds to a nominal after-tax return of 12.5%.) If the investment is amortized over five years, this return requires an annual after-tax capital charge of 25%. If the investment is amortized over seven years, the capital charge falls to 20%. These charges imply that an ILEC would have to achieve after-tax cash flows of 20 to 25% of the investment in DSL assets. In other words, if DSL requires an investment of $400 per subscriber, the service would have to generate $80 to $100 per subscriber per year after taxes, but before depreciation, to be profitable. For the model runs described below, we used a hurdle rate of 20% before taxes to calculate present values given that corporate tax rates are about 36% of before-tax profits. We calculated present values as the discounted cash flows over ten years plus a terminal value that is equal to the present value of the tenth year's discounted cash flow carried forward in perpetuity.

With the cost assumptions described above and the demand assumptions in **Table 5.1**, it is clear that initial annual service prices of $480, $360, and $360 that decline at a 10% rate are not sufficient to generate a positive net present value (**Table 5.2**). The firm realizes -$0.9 million in net present value, but this included $5.1 million of terminal value at the end of year ten. Its cash flows over years three through ten are insufficient to offset $30 million in negative cash flows in the first two years. The net present value of the investment only turns positive when the ILEC decides not to serve rural areas at all.

If the ILEC and its rivals charged slightly higher initial prices in urban and suburban areas — $420 per year — the results would be far better. The ILEC would realize a net present value of $18.7 million, but $8.4 million of this total reflects the terminal value after year ten. The cash